APPLICATION UNDER UNITED STATES PATENT LAWS

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Invention: ELECTRONIC APPARATUS, RADIO COMMUNICATION APPARATUS, AND DISPATCH ELECTRONIC CONTROL METHOD

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This is a:

☐ Provisional Application

☒ Regular Utility Application

☐ Continuing Application
  ☐ The contents of the parent are incorporated
    by reference

☐ PCT National Phase Application

☐ Design Application

☐ Reissue Application

☐ Plant Application

☐ Substitute Specification
  Sub. Spec Filed _____
        in App. No. _____/_____

☐ Marked up Specification re
  Sub. Spec. filed _____
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SPECIFICATION

TITLE OF THE INVENTION

ELECTRONIC APPARATUS, RADIO COMMUNICATION APPARATUS, AND DISPATCH ELECTRONIC CONTROL METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2002-374516, filed December 25, 2002, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a power saving technique used during radio communications carried out in conformity with a radio communication standard such as IEEE802.11 or Bluetooth(R).

2. Description of the Related Art

In recent years, battery-driven portable personal computers have been popularized. Many of the recent personal computers of this kind comprise, for example, a radio communication module which is connected to a LAN or which transmits and receives data directly to and from other electronic apparatus.

Furthermore, in general, battery-driven electronic apparatus performs various power saving operations in order to make continuous battery-driven operation time as long as possible. These operations include power saving control carried out for radio communications

using the previously described radio communication
module (refer to, for example, the specification of
U.S. Patent No. 6,256,476).

In the telephone system described in the

5   specification of U.S. Patent No. 6,256,476, a master
telephone monitors signals dispatched by a slave
telephone for their quality. If the quality falls
below a predetermined value, the master telephone
instructs the slave telephone to increase power

10 required to dispatch signals. Thus, the slave
telephone basically transmits signals with a low
dispatch power and increases the dispatch power as
required. That is, this telephone system realizes
power saving control which sets the dispatch power for

15 the battery-driven slave telephone to an appropriate
value in accordance with the situation.

In this connection, the telephone system described
in the specification of U.S. Patent No. 6,256,476
monitors signals dispatched by the slave telephone for

20 their quality using an RSSI (Receive Signal Strength
Indicator). That is, the system controls the signal
dispatch power on the basis of the strength of signals.
With this system, the master telephone and the slave
telephone are assumed to execute radio communications

25 in a stable environment, for example, inside the same
room. Thus, the monitoring based on the RSSI creates
almost no problems.

On the other hand, if an unspecified number of personal computers are connected to a wireless LAN installed in an unstable environment such as the outdoors, for example, in a station yard, an airport, or a restaurant, the signal dispatch power should be increased depending on the situation, even with a satisfactory RSSI value. However, in this case, incorrect control is likely to be provided by the power saving control method implemented by the telephone system described in the specification of U.S. Patent No. 6,256,476.

BRIEF SUMMARY OF THE INVENTION

According to an embodiment of the present invention, an electronic apparatus comprises a radio communication unit configured to carry out radio communications with external apparatus, a monitoring unit configured to monitor quality of radio communications carried out by the radio communication unit, and a control unit configured to control dispatch power for radio communications carried out by the radio communication unit on the basis of results of the monitoring executed by the monitoring unit.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description

given above and the detailed description of the

embodiments given below, serve to explain the

principles of the invention.

FIG. 1 is a diagram showing the connection form of

5· a network system according to a first embodiment of the

present invention;

FIG. 2 is a diagram schematically showing the

configuration of a personal computer according to the

first embodiment;

10 FIG. 3 is a flow chart showing the operational

procedure of power saving control carried out by a base

band unit of a radio communication module mounted in

the personal computer according to the first

embodiment; and

15 FIG. 4 is a flow chart showing the operational

procedure of power saving control carried out by a base

band unit of a radio communication module mounted in

an access point according to the first embodiment.

DETAILED DESCRIPTION OF THE INVENTION

20 Embodiments of the present invention will be

described with reference to the drawings.

(First Embodiment)

First, a first embodiment of the present invention

will be described.

25 FIG. 1 is a diagram showing the connection form of

a network system according to this embodiment of the

present invention.

In the network system according to this embodiment, a plurality of personal computers (PC) 2a, 2b, ... are connected to a network 3 via an access point (AP) 1 without any cables. Thus, both the access point 1 and the personal computers 2a, 2b, ... are provided with a radio communication module that carries out radio communications in conformity with the Bluetooth(R) protocol. This network system is characterized in that each of the personal computers 2a, 2b, ... controls its dispatch power for radio communications in order to save power. This will be described below in detail. In the description below, the personal computers 2a, 2b, ... may be generally called a "personal computer 2".

FIG. 2 is a diagram schematically showing the configuration of the personal computer 2.

The personal computer 2 is of, for example, a notebook type that can be driven by batteries. As shown in FIG. 2, a CPU 11, a RAM 12, an HDD 13, a keyboard controller 14, a display controller 15, and a radio communication module 16 are connected to a system bus.

The CPU 11 controls the whole personal computer 2 and executes various programs stored in the RAM 12. The RAM 12 is a storage medium used as a main storage for the personal computer 2 to store various programs executed by the CPU 11 and various data used for these

programs. The programs stored in the RAM 12 include

a power saving utility program 121, described later.

On the other hand, the HDD 13 is s storage medium used

as an external storage for the personal computer 2.

The HDD 13 acts as an auxiliary device for the RAM 12

to store a large amount of various programs and data.

Furthermore, the keyboard controller 14 is

a device working as an input side of a user interface

of the personal computer 2. The keyboard controller 14

transmits the contents of operations performed on

a keyboard 14 or a mouse 142. On the other hand,

a display controller 15 is a device working as

an output side of the user interface of the personal

computer 2. The display controller 15 displays image

data created by the CPU 11, on an LCD 151.

The radio communication module 16 carries out

radio communications in conformity with the

Bluetooth(R) protocol. The radio communication module

16 has an interface unit 161, an E^2PROM 162, a base

band unit 163, an RF unit 164, an antenna 165. The

radio communication module 16 may be composed of a

standard unit already contained in the personal

computer 2 or an expanded unit housed in, for example,

an expansion slot in the personal computer 2, as

required.

The interface unit 161 is a bridge circuit used to

incorporate the radio communication module 16 into the

personal computer 2.   The interface unit 161 loads

commands or transmitted data from the CPU 11 and sends

data received from the access point 1, out to the

system bus.   The E^2PROM 162 is a storage medium to

5   which set values that set an operating environment for

the radio communication module 16 are saved.

The base band unit 163 has all basic functions

for radio communications in accordance with the

Bluetooth(R) protocol, for example, the functions of

10   creating packets and determining a frequency hopping

pattern.   Furthermore, the base band unit 163 has

a function of calculating the throughput of radio

communications on the basis of a bit error rate (BER)

and computing reception sensitivity on the basis of

15   a signal-to-noise ratio (SNR).   The current radio

communication in operation can be monitored for its

quality using the throughput calculated on the basis of

the bit error rate (BER) or the reception sensitivity

computed on the basis of the signal-to-noise ratio

20   (SNR).

The RF (Radio Frequency) unit 164 dispatches

transmitted data received from the base band unit 163,

from the antenna 165, using a carrier with a frequency

specified by the base band unit 163.   The RF unit 164

25   also loads, through the antenna 165, received data

superimposed on a carrier with a frequency specified by

the base band unit 163, and delivers the data to

the base band unit 163. Furthermore, the RF unit 164 has a function of switching dispatch power required to dispatch transmitted data from the antenna 165, among multiple levels in accordance with an instruction given by the base band unit 163.

As described previously, the base band unit 163 controls the power required by the RF unit 164 to dispatch transmitted data. Then, if the base band unit 163, monitoring radio communications for quality, determines that it is appropriate, it instructs the RF unit 164 to reduce the dispatch power for the transmitted data. On the other hand, if the base band unit 163 determines that radio communications are degraded, it instructs the RF unit 164 to increase the dispatch power for the transmitted data.

Specifically, the base band unit 163 thus controls the RF unit 164 to switch the dispatch power for radio communications on the basis of the current communication quality. Consequently, each personal computer 2 appropriately saves power without relying only on the strength of signals.

Furthermore, the base band unit 163 determines on the basis of the set values in the E^2PROM 162 whether or not to execute the monitoring of radio communications for their quality and the switching control of the dispatch power based on the results of the monitoring. The power saving utility program 121

sets the values in the E^2PROM 162. The power saving
utility program 121 determines whether or not
an external commercial power source is present, that
is, whether or not the computer is driven by batteries.
Then, if the computer is driven by batteries, the power
saving utility program 121 makes settings required to
cause the base band unit 163 to execute the monitoring
and switching control.

FIG. 3 is a flow chart showing the operational
procedure of power saving control executed by the base
band unit 163.

When radio communication is started, the base band
unit 163 first sets the dispatch power at its maximum
value (step A1). Then, the base band unit 163 monitors
the radio communication for its quality (step A2). If
the quality is high (YES in step A3), the base band
unit 163 changes the setting so as to reduce the
dispatch power by one level (step A4).

On the other hand, if the quality is low (NO in
step A3 and YES in step A5), the base band unit 163
changes the setting so as to increase the dispatch
power by one level (step A6). That is, the base band
unit 163 has two thresholds for an upper limit and
a lower limit, respectively. It carries out switching
so as to reduce the dispatch power if the BER or SNR
has exceeded the upper limit. In contrast, it carries
out switching so as to increase the dispatch power if

the BER or SNR has exceeded the lower limit. If the
BER and SNR are each within the range between the two
thresholds (NO in step A3 and NO in step S5), the base
band unit 163 maintains the current dispatch power.

5   After this series of operations, the base band
unit 163 stands by for a predetermined time (step A7)
and then repeats the process starting with step A2.

          As described above, each personal computer 2
properly controls the dispatch power for radio

10   communications on the basis of the communication
quality, in order to save power.
(Second Embodiment)

          Next, a second embodiment of the present invention
will be described.

15   A network system according to the second
embodiment differs from the network according to the
previously described first embodiment in that in the
network system according to the first embodiment, each
personal computer 2 independently controls its dispatch

20   power for radio communications, whereas in the network
system according to the second embodiment, the access
point executes unified control and instructs each
personal computer 2 to change its dispatch power as
required.

25   Specifically, the base band unit 163 mounted in at
access point 1 monitors each personal computer 2 for
the quality of a radio communication being executed by

the computer. On the basis of the results of the monitoring, the base band unit 163 transmits control data required to change the dispatch power as required. The configuration of the apparatus of the access point 1 is almost the same as that of the personal computer 2, shown in FIG. 2. Accordingly, its description is omitted.

FIG. 4 is a flow chart showing the operational procedure of power saving control executed by the base band unit 163 of the access point 1 according to the second embodiment.

If any personal computer 2 starts radio communication with the access point 1, the base band unit 163 first transmits control data instructing the personal computer 2 to set the dispatch power at its maximum value (step B1). Then, the base band unit 163 monitors the radio communication with this personal computer 2 for its quality (step B2). If the quality is high (YES in step B3), the base band unit 163 transmits control data instructing the personal computer 2 to change the setting so as to reduce the dispatch power by one level (step B4).

On the other hand, if the quality is low (NO in step B3 and YES in step B5), the base band unit 163 transmits control data instructing the personal computer 2 to change the setting so as to increase the dispatch power by one level (step B6). That is, the

base band unit 163 of the access point 1 has two
thresholds for an upper limit and a lower limit,
respectively. It carries out switching so as to reduce
the dispatch power if the BER or SNR has exceeded the

5   upper limit. In contrast, it carries out switching so
as to increase the dispatch power if the BER or SNR has
exceeded the lower limit. If the BER and SNR are each
within the range between the two thresholds (NO in step
B3 and NO in step B5), the base band unit 163 maintains

10   the current dispatch power.

         After the series of operations, the base band unit
163 stands by for a predetermined time (step B7) and
then repeats the process starting with step B2.

         As described above, under the control of the

15   access point 1, each personal computer 2 properly
controls the dispatch power for radio communications on
the basis of the communication quality, in order to
save power.

         In the previously described examples of the first

20   and second embodiments, the dispatch power for radio
communications between the access point 1 and the
personal computer 2 is controlled. However, the
present invention is not limited to this aspect. When
a plurality of personal computers 2 performs radio

25   communications each other, the plurality of personal
computers 2 may each execute control independently or
one of them may independently control itself, while

controlling the other.

Furthermore, in the description of the above example, the base band unit 163 of the radio communication module 16 controls the dispatch power for radio communications. However, this control may be executed by a program such as the power saving utility program 121 which is run by the CPU 11. This program gives instructions to the radio communication module 16 on the basis of the settings in the E^2PROM 162.

Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.